Page Denied

Next 1 Page(s) In Document Denied

CORNING GLASS WORKS

ELECTRO-OPTICS LABORATORY

RALEIGH, NORTH CAROLINA

IMPROVED SCREEN FOR REAR PROJECTION VIEWERS

Technical Report No. - 24

Date - July 21, 1967

Period Covered - June 23, 1967

to

July 21, 1967

ABSTRACT

A beaded screen which should give optimum image brightness and contrast is described. Prototype screens will be fabricated for evaluation.

A technique of masking beaded screens utilizing positive-working photosensitive materials is discussed. Initial experiments using a photosensitive resist gave unsatisfactory results. A positive-working photographic emulsion has been obtained and is expected to give an improvement.

The spectral transmittance of several Corning and commercial screens has been measured. The relative magnitude of the change in transmittance over the spectral range explains the apparent yellowish tint and corresponding lack of color fidelity of diffusing screens as compared to beaded screens.

Some 3" x 3" Fotoform® glass screens will be received shortly and will be evaluated.

25X1

CONFIDENTIAL

EXCLUDED FROM AUTOMATIC REGRADING; DOD DIR 5200.10 DOES NOT APPLY

CORNING GLASS WORKS

ELECTRO-OPTICS LABORATORY

RALEIGH, NORTH CAROLINA

IMPROVED SCREEN FOR REAR PROJECTION VIEWERS

Technical Report No. - 24

Date - July 21, 1967

Period Covered - June 23, 1967

to

July 21, 1967

25X1

CONFIDENTIAL

ABSTRACT

A beaded screen which should give optimum image brightness and contrast is described. Prototype screens will be fabricated for evaluation.

A technique of masking beaded screens utilizing positive-working photosensitive materials is discussed. Initial experiments using a photosensitive resist gave unsatisfactory results. A positive-working photographic emulsion has been obtained and is expected to give an improvement.

The spectral transmittance of several Corning and commercial screens has been measured. The relative magnitude of the change in transmittance over the spectral range explains the apparent yellowish tint and corresponding lack of color fidelity of diffusing screens as compared to beaded screens.

Some 3" x 3" Fotoform® glass screens will be received shortly and will be evaluated.

CORNING GLASS WORKS

ELECTRO-OPTICS LABORATORY

RALEIGH, NORTH CAROLINA

IMPROVED SCREEN FOR REAR PROJECTION VIEWERS

Technical Report No. - 24

Date - July 21, 1967

Period Covered - June 23, 1967
to
July 21, 1967

25X1

TECHNICAL REPORT NO. 24

I. Optimum Beaded Screen

The visibility of an image viewed on a rear projection screen depends on image brightness and contrast. If the screen resolution is sufficient, then the screen properties which govern image brightness and contrast are the diffuse transmittance, T_{90}, and the diffuse reflectance, R_D. It is convenient to define an ambient light transmission coefficient T_A, where $T_A = K(1-R_D)$, and K is a constant which can be determined experimentally. Then T_{90} is the fraction of the incident projector light which is transmitted through the screen, and T_A is the fraction of the incident ambient light which is transmitted through the screen, and these two transmission coefficients are in general different for a given beaded screen. One might ask what values of T_{90} and T_A will maximize image brightness and contrast, and whether such an optimum screen can be obtained. Obviously, image brightness is maximized by maximizing T_{90}, and image contrast is maximized by maximizing T_A, i.e. minimizing R_D.

Now recall that type I beaded screens[1] have low R_D values (and thus large T_A values), but have only moderate T_{90} values because a portion of the projector light is totally internally reflected back toward the projector, while type II screens have large T_{90} values, but have higher R_D values (and thus lower T_A values), because a portion of the ambient light is totally reflected back to the viewer. So a screen combining the desirable properties of both screen types, i.e. large T_{90} and large T_A, is the optimum screen which we seek.

---
[1] See Technical Report No. 23 for a discussion of beaded screen types.

An approximation to this screen can be obtained. In Fig. 1, T_{90} and T_A are plotted as a function of n_3/n_1 for $n_1/n_2 = 0.8$, where n_2 = bead refractive index, and for $n_3/n_1 \leq 1, n_1$ = index of embedding plastic and n_3 = air index, while for $n_3/n_1 > 1$, the definitions of n_1 and n_3 are interchanged[2]. To choose the optimum screen indices, we first require that T_{90} be maximized, and this dictates that $n_3/n_1 \geq 1$ (see Fig. 1). The other requirement, that T_A be a maximum, dictates that $0.9 \leq n_3/n_1 \leq 1.0$. Then simultaneous satisfaction of the two requirements indicates that $n_3/n_1 = 1$ for the optimum screen. Fig. 1 shows that such a screen would have T_{90} and T_A values greater than 90%. However, within the framework of the index definitions for type I and type II screens, $n_3/n_1 = 1$ requires that the embedding plastic have an index of 1, and such a plastic is not available. An approximation to such a screen can be obtained by completely embedding the beads in a typical plastic of index 1.5, as shown in Fig. 2. This screen could be made from a normal type I beaded screen by simply adding another plastic layer over the beads. T_{90} and T_A values were calculated for this optimum screen, using 0.8 as the ratio of plastic and glass indices. The values were both equal to 79% and are plotted in Fig. 1 as optimum values. The values are less than 90% because although total internal reflection within the beads has been eliminated, it still occurs at the air-screen interfaces. The calculated axial gain of this screen is 5.1, and higher or lower gains can be obtained by varying the bead index n_2, with corresponding increases and decreases in T_{90} because of the varying amount of total internal reflection. A prototype screen of

[2] See Technical Report No. 23.

this type will be fabricated for evaluation. Note that this optimization is valid in terms of T_{45} also, because maximizing T_{90} also maximizes T_{45}.

9

II. Masking of Beaded Screens

The work concerning the masking of beaded screens has been directed toward the utilization of photosensitive materials to form a mask. Suppose the viewing side of a type I beaded screen is coated with a positive-working photosensitive material and that sensitizing radiation is projected onto the screen from the projector side, as in a normal viewing situation. This radiation will be focused through the beads, and only an area on the bead the size of the exit window will be exposed. Because the material is positive working, a subsequent developing process will remove the material from the exposed areas, i.e. the bead windows, while the unexposed material remains on the screen. The unexposed material is either dark originally or else is darkened during the developing process, and so a mask is formed. This technique automatically compensates for variation in bead size, as each bead optically forms its own exit window of the proper size.

A positive-working photosensitive resist which is sensitive to ultraviolet radiation was used in initial experiments. A variety of practical problems were encountered in using the resist as a masking material, and the resist was very transparent, even when dye was added in recommended proportions. Because of these problems, satisfactory results were not obtained.

The difficulties with the resist motivated a search for other applicable photosensitive materials, and a positive-working photographic emulsion has been obtained. The practical problems associated with the utilization of the emulsion are fewer than with the resist, and the emulsion has a higher optical density than does the resist. Work is continuing in this area.

III. Color Fidelity

An important property of a rear projection screen is its color fidelity, i.e. the degree to which the screen faithfully reproduces the colors present in a transparency which is projected upon it. If the transmission of a screen varies appreciably with light wavelength, then color distortion results. Observations of a variety of diffusing screens, both commercial and Corning, and beaded screens have indicated subjectively that the beaded screens exhibit superior color fidelity, as the diffusing screens appear to have a yellowish tint when compared to beaded screens. In order to provide objective substantiation of these observations, the spectral transmittance was measured as a function of wavelength for some commercial and Corning screen samples, and the results are shown in Fig. 3. The spectral range covered is from 400 to 600 millimicrons. The diffusing screens exhibit increases in spectral transmittance ranging from 13 to 20%, while for the beaded screen it increases only 5%. The fact that the change in spectral transmittance for the diffusing screens is a factor of two to three larger than that for the beaded screen certainly accounts for the apparent yellowish tint of the diffusing screens when compared to beaded screens. This is typical of small particle Mie scattering, which has a small but significant dependence on wavelength. The only mechanism for color distortion in beaded screens is dispersion, and this is generally a very small effect.

IV. Fotoform® Glass Screens

The 8" x 10" Fotoform® glass screens mentioned in previous reports were broken during a grinding and polishing operation. Some 3" x 3" sections were salvaged, and will be evaluated. The breakage was due to insufficient thickness of the unfinished screens.

Fig. 1 T_{90} and T_A as a function of n_3/n_1 for $n_1/n_2 = 0.8$

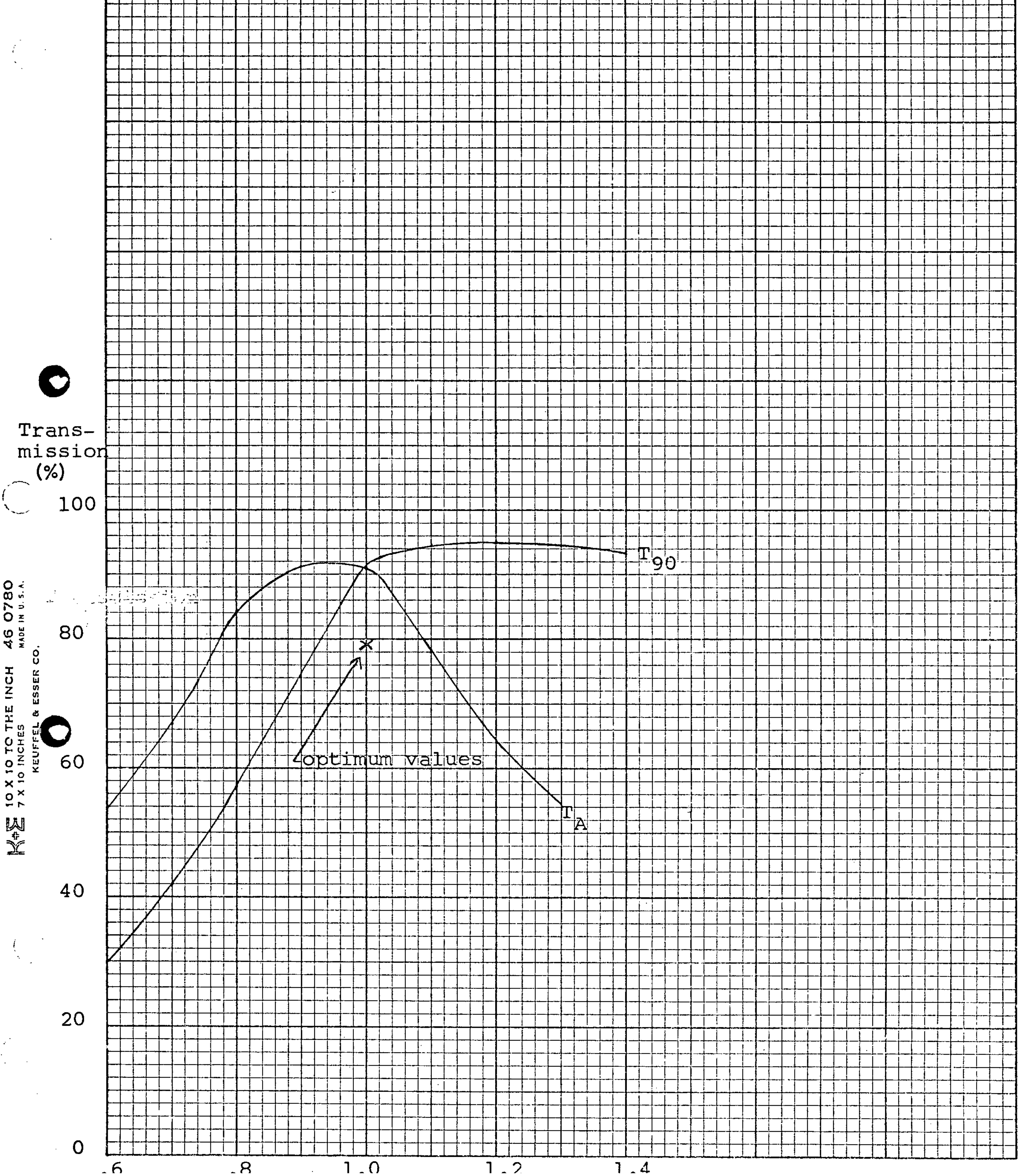
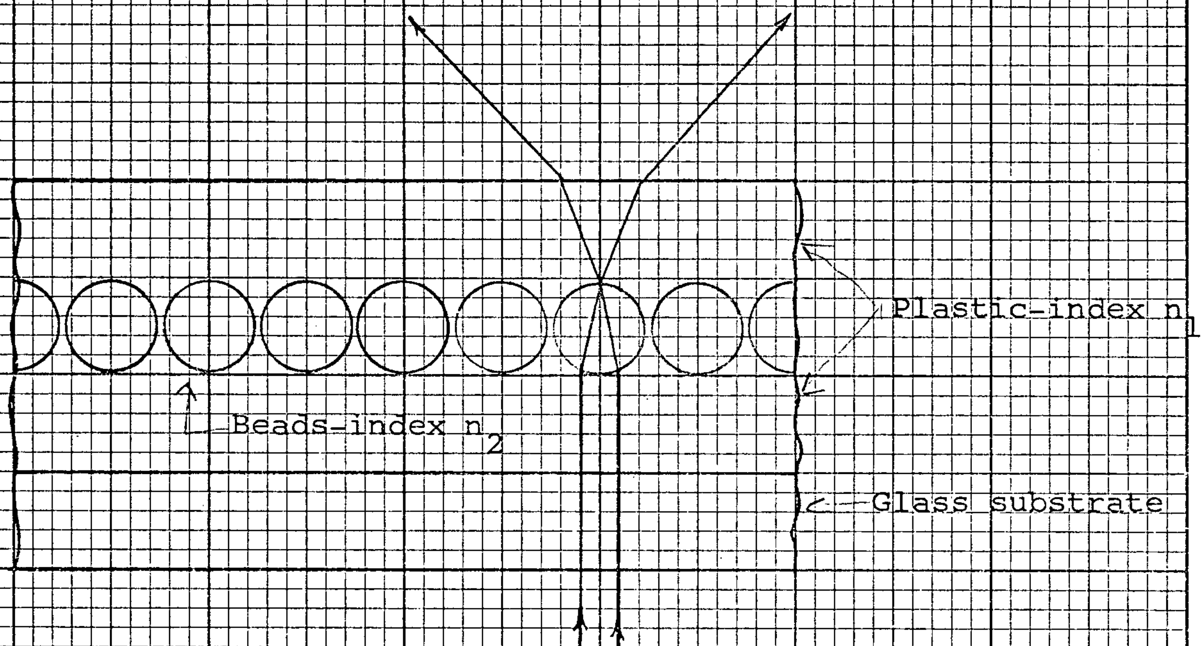
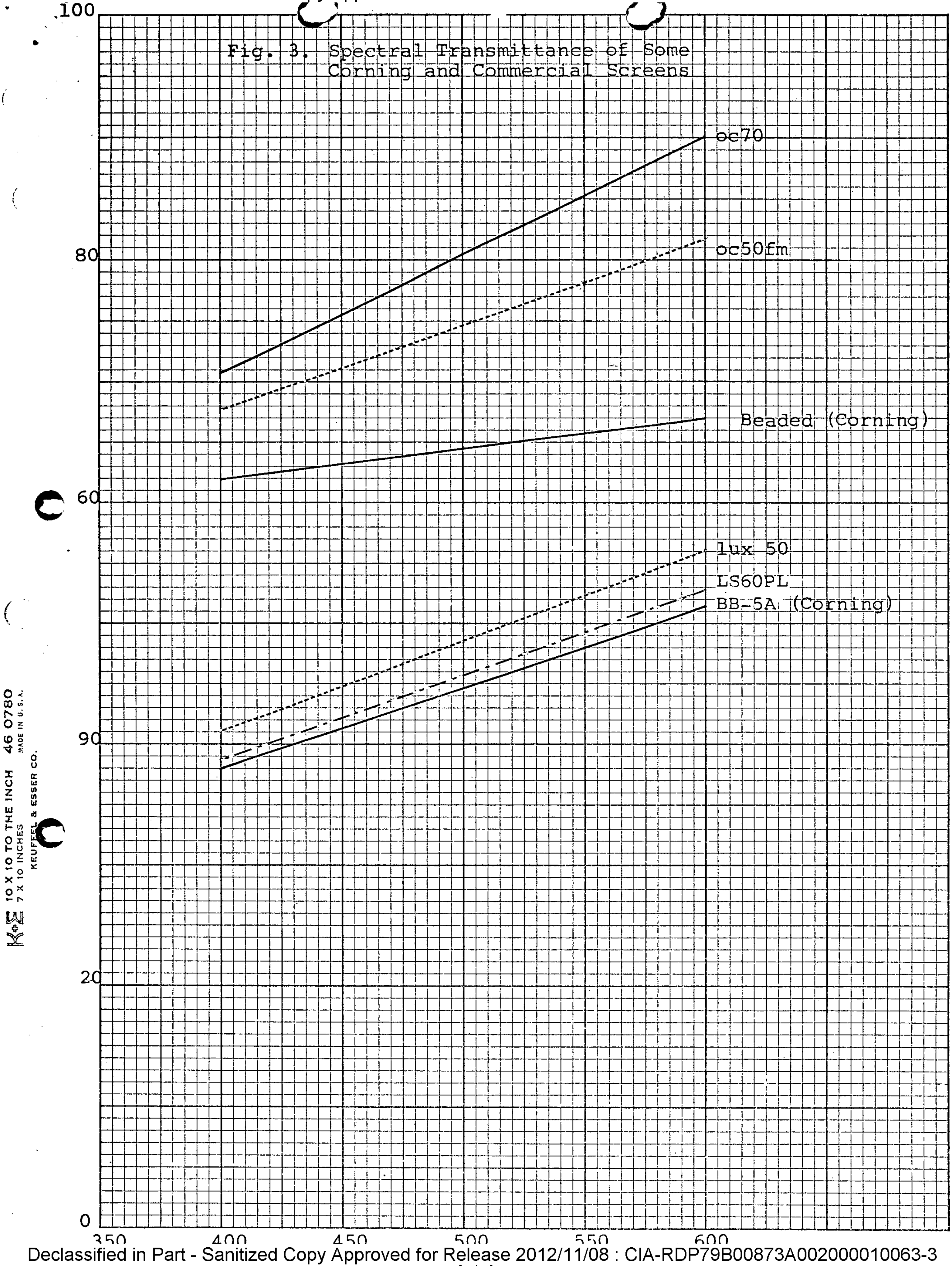


Fig. 2 Configuration of optimum beaded screen



Declassified in Part - Sanitized Copy Approved for Release 2012/11/08 : CIA-RDP79B00873A002000010063-3



Declassified in Part - Sanitized Copy Approved for Release 2012/11/08 : CIA-RDP79B00873A002000010063-3

Page Denied

Next 1 Page(s) In Document Denied